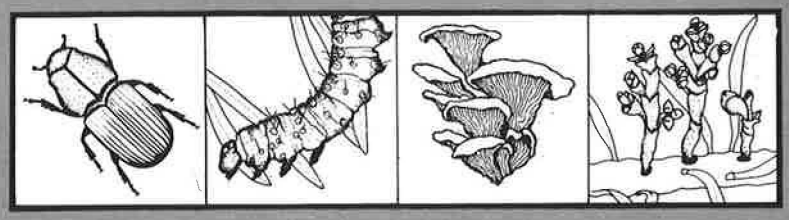
Forest Pest Management



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PERMANENT PLOTS FOR STUDYING THE SPREAD AND INTENSIFICATION OF LARCH DWARF MISTLETOE AND THE EFFECTS OF THE PARASITE ON GROWTH OF INFECTED WESTERN LARCH ON THE FLATHEAD INDIAN RESERVATION, MONTANA.

by

Jane Taylor [1], Terry Reedy [2], and Tom Corse [2]

INTRODUCTION

Western larch dwarf mistletoe (*Arceuthobium laricis* (Piper) St. John) is a wide-spread forest disease agent that occurs throughout the range of western larch (*Larix occidentalis* Nutt.) in the northwestern United States. Dwarf mistletoes are parasitic plants that depend on their conifer hosts for water and nutrients, causing reduced vigor, decreased diameter and height growth, reduction in cone and seed crops, and mortality.

Information that quantifies the spread and intensification of dwarf mistletoes and their effects on tree growth and mortality is necessary for formulating disease management strategies. Some information is available for other dwarf mistletoe species, particularly, lodgepole pine dwarf mistletoe (*A. americanum*) (Hawksworth and Johnson 1989). However, very little data is available for western larch dwarf mistletoe (WLDM). Most of the current information is based on data from unmanaged stands, or stands managed under even-aged systems.

Traditionally, silvicultural management of dwarf mistletoe has been based on even-aged management because control of dwarf mistletoe is best achieved through the removal of infected stands and replacement with mistletoe-free regeneration (e.g., clear cuts, and seed tree and shelterwood cuts in which the residual overstory is promptly removed following stand regeneration) (Hawksworth and Johnson 1989). However, with the current pressures to limit clear cutting and to leave residuals on a site until visual recovery has been achieved, forest managers are starting to explore alternative treatments of dwarf-mistletoe-infected stands. As a result, many questions are being raised about the impacts of dwarf mistletoe on the productivity of stands managed under uneven-aged systems. Unfortunately, there is not much data available at this time to answer most of these questions.

[1] Plant Pathologist, Timber, Cooperative Forestry and Pest Management
[2] Foresters, Bureau of Indian Affairs, Flathead Agency

United States Department of Agriculture | Forest Service | **Northern Region** | P.O. Box 7669 Missoula, Montana 59807

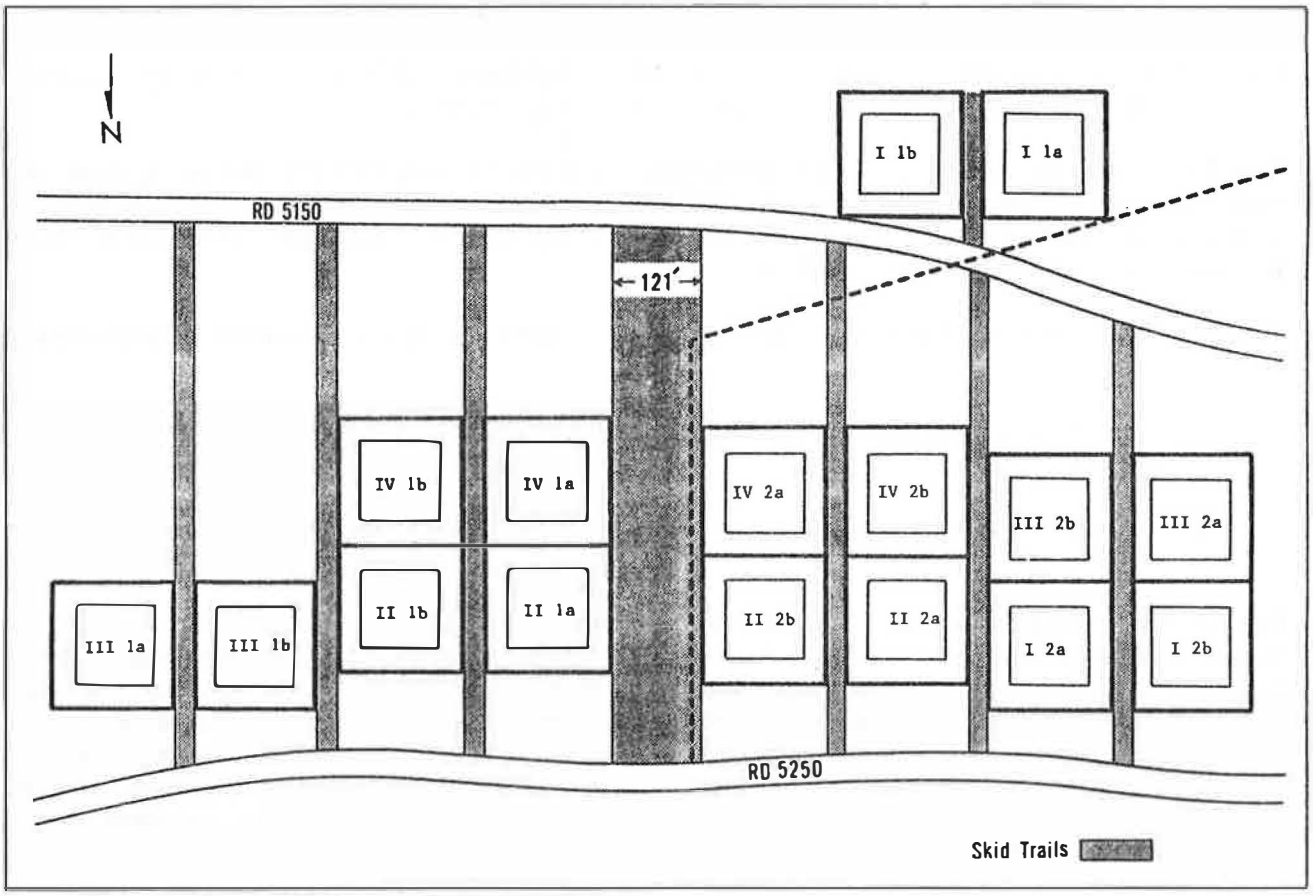

Figure 1–Map of plot layout: I-IV = replication number; 1 = overstory removal, 2 = no overstory removal; a = thinned to a 12- x 12-foot spacing; b = no thinning. The heavy dotted line indicates the approximate boundary between the part of the stand where overstory removal was performed (to the left) and the part of the stand not logged (to the right).

DATA ANALYSIS

All subplots were representative of the *Abies lasiocarpa/Clintonia uniflora* habitat type. Fourteen were representative of the *Menziesia ferruginea* phase. One was representative of the *Xerophyllum tenax* phase, and one was representative of the *Aralia nudicaulis* phase. Subplot slopes ranged from 17 to 46 percent with generally northern aspects (NNW, N, and NNE).

A total of 4,027 understory trees of all species were sampled, including tagged crop trees and trees on one-hundredth-acre sample plots. Of this total, 1,694 (42 percent) were infected. The average DMR ($\overline{DMR}$) of all sampled understory trees was .58 and the average DMR of the infected trees ($\overline{DMI}$) was 1.39. Three thousand four hundred seventy-five (85 percent) of all sampled understory trees were western larch; 49 percent of the larch were infected. The $\overline{DMR}$ of all larch understory trees was .67.

The characteristics of understory trees on each subplot are summarized in Table 1. This information was calculated from data taken for understory trees on one-hundredth-acre sample plots. Data for trees on thinned subplots were taken prior to treatment. Subplot stocking was quite variable, ranging from 680 to 8,280 trees per acre with a mean of 3,488 trees per acre (sd=1,991). The percent of trees infected on each subplot was also variable, ranging from 1.3 to 69.1 percent with a mean of 40 percent (sd=20.56). Western larch was a large component of all plots, ranging from 44 to 99 percent with a mean of 85 percent (sd=16.21).

A total of 1,237 understory trees were tagged as comparable crop trees and 693 (56 percent) of this total were infected. The $\overline{DMR}$ of all crop trees was .80 and the $\overline{DMI}$ was 1.34. Nine hundred eighty-four (80 percent) of the crop trees were western larch and 70 percent of the larch were infected. The $\overline{DMR}$ of the larch crop trees was .94.

The characteristics for designated crop trees on each subplot are summarized in Table 2. The percent total crop trees infected ranged from 4 to 80 percent with a mean of 58 percent (sd=20.07) and the percent larch infected ranged from 4 to 92 percent with a mean of 73 percent (sd=23.78). Subplot $\overline{DMR}$ ranged from .04 to 1.25 with a mean of .80 (sd=.31). Subplot $\overline{DMI}$ ranged from 1.00 to 1.58 with a mean of 1.34 (sd=.16).

Infection data for crop trees were broken down by the number of trees in each DMR class and by the number of trees with infections in each crown-third (lower, middle, upper) (Table 3). All trees but one had a DMR of 3 or less, and 69 percent of all infected trees had a DMR of 1. Ninety-eight percent of infected trees had infections in the lower crown third while only 0.3 percent had infections in the upper crown third.

The data presented in Tables 1, 2, and 3 show that the incidence of dwarf mistletoe infection in the understory trees was quite high even though the understory trees are less than 20 years old. However, the severity of infection in individual understory trees throughout the stand was low.

The height of infected crop trees ranged from 2.5 to 31.8 feet with a mean of 13.1 feet (sd=5.7) and the height of non-infected, understory trees ranged from 1.3 to 29.0 feet with a mean of 8.7 feet (sd=5.0). The d.b.h. of infected crop trees ranged from 0.1 to 4.2 inches with a mean of 1.2 inches (sd=0.7) and the d.b.h. of non-infected crop trees ranged from 0.1 to 3.1 inches with a mean of 0.8 inches (sd=0.6). Mean heights and d.b.h.'s were computed for infected and non-infected crop trees on each of the 16 subplots (Table 4). Students t-tests (Schefler 1980) were used to test the difference between the means for the height of infected trees versus the height of non-infected trees and for the d.b.h. of infected trees versus the d.b.h. of non-infected trees. Results showed that infected trees were significantly taller and bigger in diameter than non-infected trees. These results indicate that dwarf mistletoe infection is not yet causing any growth effects in these understory trees and suggest that the bigger the tree, the greater its probability of becoming infected because it poses a larger target for the reception of dwarf mistletoe seeds.

Table 2.--Number of trees, number of western larch (# WL), percent composition of western larch (% WL), number infected (# INF), percent infected (% INF), percent western larch infected (% WL INF), average dwarf mistletoe rating (DMR), average dwarf mistletoe rating of infected trees (DMI), average height (HGHT), and average diameter at breast height (DBH) for understory crop trees on each subplot, grouped by treatment.

	# Trees	# WL	% WL	# INF	% INF	% WL INF	$\overline{DMR}$	$\overline{DMI}$	HGHT (ft)	DBH (in)
Logged, Thinned										
I 1a	98	70	71.4	48	49.0	68.6	0.64	1.31	11.1	1.1
II 1a	95	85	89.5	73	76.8	85.9	1.11	1.44	11.2	1.1
III 1a	82	62	75.6	49	59.8	79.0	0.70	1.16	11.8	1.2
IV 1a	77	65	84.4	51	66.2	78.5	0.83	1.26	7.0	0.6
$\bar{x}$	88	71	80.2	55	62.3	78.0	0.82	1.29	10.3	1.0
Logged, Unthinned										
I 1b	85	65	76.5	52	61.2	80.0	0.88	1.44	8.2	0.7
II 1b	66	62	93.9	53	80.3	85.5	1.09	1.36	17.7	1.8
III 1b	95	80	84.2	25	26.3	31.3	0.27	1.04	10.7	1.1
IV 1b	76	57	75.0	46	60.5	80.7	0.83	1.37	9.2	0.7
$\bar{x}$	81	66	82.4	44	57.1	69.4	0.77	1.30	11.5	1.1
Unlogged, Thinned										
I 2a	68	59	86.8	54	79.4	91.5	1.25	1.57	13.9	1.3
II 2a	59	41	69.5	35	59.9	85.4	0.83	1.40	10.7	1.1
III 2a	69	47	68.1	36	52.2	76.6	0.71	1.36	12.7	1.2
IV 2a	83	75	90.4	41	49.4	54.7	0.60	1.22	11.5	0.9
$\bar{x}$	70	56	78.7	42	60.2	77.1	0.85	1.39	12.2	1.1
Unlogged, Unthinned										
I 2b	48	43	89.6	38	79.2	88.4	1.17	1.47	16.2	1.9
II 2b	83	70	84.3	3	3.6	4.3	0.04	1.00	14.3	1.2
III 2b	80	53	66.3	43	53.8	81.1	0.85	1.58	7.9	0.7
IV 2b	73	50	68.4	46	63.0	92.0	0.93	1.48	9.3	0.8
$\bar{x}$	71	54	77.2	33	49.9	66.5	0.75	1.38	11.9	1.2
Totals	1,237	984		693						
Total mean	77	61.5	79.6	43	57.5	72.7	0.80	1.34	11.46	1.09

Table 4.--Average height (HGHT) and average diameter at breast height (DBH) for dwarf mistletoe-infected and non-infected understory crop trees for each subplot, grouped by treatment.

	Infected		Non-infected	
	HGHT	DBH	HGHT (ft)	DBH (in)
Logged, Thinned				
I 1a	12.6	1.2	9.8	0.9
II 1a	12.8	1.2	5.9	0.5
III 1a	8.6	0.7	4.6	0.4
IV 1a	14.0	1.3	7.6	0.7
Logged, Unthinned				
I 1b	9.5	0.9	6.1	0.4
II 1b	18.7	1.9	13.5	1.2
III 1b	11.6	0.9	8.3	0.7
IV 1b	12.6	1.2	7.7	0.8
Unlogged, Thinned				
I 2a	14.8	1.3	10.3	1.1
II 2a	15.6	1.4	8.6	0.8
III 2a	14.3	1.4	6.7	0.6
IV 2a	14.0	1.2	9.0	0.7
Unlogged, Unthinned				
I 2b	17.6	2.1	11.0	1.2
II 2b	20.7	1.8	14.0	1.2
III 2b	10.0	0.8	5.4	0.6
IV 2b	10.7	0.9	7.0	0.7

Table 5.--Number of trees, average height (HGHT), average diameter at breast height (DBH), basal area (BA), and age of overstory trees for each subplot, grouped by treatment.

	No. of trees	HGHT (ft)	DBH (in)	BA (ft^2/ac)	Age
Logged, Thinned*					
I 1a	6	64.2	10.6	15.20	196
II 1a	6	107.8	22.1	64.12	182
III 1a	11	86.1	14.9	57.72	196
IV 1a	15	104.6	17.3	35.49	194
$\bar{x}$	10	90.7	6.2	43.13	192
Logged, Unthinned*					
I 1b	16	65.8	10.6	43.70	195
II 1b	1	127.0	24.3	12.88	191
III 1b	4	82.0	15.0	21.64	191
IV 1b	5	104.0	19.4	43.64	191
$\bar{x}$	7	94.7	17.3	30.47	192
Unlogged, Thinned					
I 2a	9	80.8	15.4	51.66	196
II 2a	9	84.3	15.6	53.36	165
III 2a	7	83.1	14.7	37.20	158
IV 2a	18	74.8	14.1	83.99	197
$\bar{x}$	11	80.8	15.0	56.55	179
Unlogged, Unthinned					
I 2b	3	69.7	15.3	16.38	152
II 2b	6	83.5	16.2	35.17	172
III 2b	9	86.9	18.5	68.82	176
IV 2b	11	81.9	13.6	45.37	161
$\bar{x}$	7	80.5	15.9	41.44	165

* Data was taken prior to logging treatment

SUMMARY

The incidence of dwarf mistletoe infection in the understory trees was high throughout the study area even though these trees were less than 20 years old. The high level of infection in the understory trees was greatly influenced by the severity level of dwarf mistletoe infection in the overstory trees. The severity of infection in individual understory trees was low and the dwarf mistletoe was not yet causing any growth effects in these trees. Statistical analysis showed that there were no significant differences between treatment groups for variables used to measure dwarf mistletoe spread and intensification and disease effects on tree growth to account for in the future analyses of treatment effects.

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